International Journal of Medical and Pharmaceutical Sciences
Open access peer-reviewed Journal
Volume 2, Issue 3, Page 387-393.
https://doi.org/10.5281/zenodo.19228102

Research Article

Association Between Dietary Phytochemical Intake and Cardiovascular Disease Risk in Adults

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Background: Cardiovascular disease (CVD) remains the leading cause of mortality worldwide. Dietary patterns rich in plant-based foods provide bioactive compounds known as phytochemicals, which exhibit antioxidant, anti-inflammatory, and lipid-lowering properties. However, the association between total dietary phytochemical intake and cardiovascular risk in adults requires further clarification. **Objective:** To examine the association between dietary phytochemical intake and cardiovascular disease risk among adults aged 30–75 years. **Methods:** A cross-sectional study was conducted among 1,200 adults recruited from community health centers. Dietary intake was assessed using a validated Food Frequency Questionnaire (FFQ), and total phytochemical intake was estimated using a Phytochemical Index (PI). Cardiovascular risk was evaluated using the Framingham Risk Score, blood pressure measurements, lipid profile (LDL-C, HDL-C, triglycerides), and inflammatory markers (C-reactive protein). Multivariable regression analysis was performed adjusting for age, sex, BMI, smoking status, and physical activity. **Results:** Participants with higher phytochemical intake demonstrated significantly lower LDL cholesterol levels ($p < 0.001$), reduced C-reactive protein concentrations ($p < 0.001$), and lower systolic blood pressure ($p = 0.002$) compared to those with lower intake. Higher phytochemical intake was independently associated with reduced predicted 10-year CVD risk ($\beta = -0.28$, $p < 0.01$). Individuals in the highest phytochemical intake quartile showed approximately 25–30% lower cardiovascular risk compared to the lowest quartile. **Conclusion:** Greater dietary phytochemical intake is significantly associated with improved cardiovascular risk profiles in adults. Promotion of phytochemical-rich diets—including fruits, vegetables, whole grains, legumes, and nuts—may serve as an effective strategy for CVD prevention.

Keywords: Cardiovascular disease; Phytochemicals; Dietary intake; Antioxidants; Inflammation; Adults.

INTRODUCTION

Cardiovascular disease CVD is the dominant cause of non-communicable disease mortality worldwide, accounting for nearly 17.9 million deaths annually according to the World Health Organization [1]. The global burden of CVD continues to rise due to aging populations, urbanization, sedentary lifestyles, and unhealthy dietary patterns [2]. Major modifiable risk factors include hypertension, dyslipidemia, obesity, type 2 diabetes mellitus, smoking, and poor diet quality. Among these, diet is recognized as one of the most significant determinants of cardiovascular health [3]. Plant-based dietary patterns have consistently been associated with reduced cardiovascular morbidity and mortality [4,5]. Such diets are rich in phytochemicals—naturally occurring bioactive compounds found in fruits, vegetables, whole grains, legumes, nuts, seeds, and other plant-derived foods [6]. Phytochemicals include diverse classes such as polyphenols, flavonoids, carotenoids, glucosinolates, and phytosterols. Although not classified as essential nutrients, these compounds exert biological effects that contribute significantly to disease prevention [7,8]. Several mechanisms explain the cardioprotective properties of phytochemicals. These compounds possess strong antioxidant activity, helping neutralize reactive oxygen species and

reducing oxidative stress—a key contributor to atherosclerosis [9]. In addition, phytochemicals demonstrate anti-inflammatory effects by modulating inflammatory cytokines and signaling pathways [10]. They also improve endothelial function, regulate lipid metabolism, inhibit LDL oxidation, and enhance nitric oxide bioavailability, thereby supporting vascular health [11]. Epidemiological studies have reported that adherence to phytochemical-rich dietary patterns, such as the Mediterranean diet, is associated with lower incidence of coronary heart disease and stroke [13]. However, while individual phytochemical classes have been extensively investigated [8], the impact of total dietary phytochemical intake on overall cardiovascular risk remains less clearly defined, particularly in diverse adult populations [14]. Therefore, the present study aims to investigate the association between total dietary phytochemical intake and cardiovascular disease risk among adults [15]. By examining clinical biomarkers and established risk scores, this research seeks to provide further evidence supporting the role of phytochemical-rich diets in cardiovascular disease prevention [4].

MATERIAL & METHODS

Study design and participants

This study was designed as a community-based cross-sectional observational study to evaluate the association between dietary phytochemical intake and cardiovascular disease (CVD) risk among adults. A total of 1,200 participants aged 30–75 years were recruited from urban and rural primary health centers during a three-month study period from December 2025 to February 2026. The study duration was limited to three months. Participants were selected using stratified random sampling to ensure appropriate representation across age groups and sex.

Inclusion Criteria

- Adults aged 30–75 years
- Permanent residents of the study area
- Provided written informed consent

Exclusion Criteria

- Diagnosed chronic kidney disease, cancer, or severe liver disease
- Pregnancy or lactation
- Current use of lipid-lowering or long-term anti-inflammatory medications
- Incomplete dietary or biochemical data

Sample Size Calculation

The sample size was determined assuming a moderate association between phytochemical intake and cardiovascular risk (effect size = 0.25), with 80% statistical power and a 95% confidence level. A minimum of 1,050 participants was required; therefore, 1,200 participants were enrolled to account for possible incomplete data.

Data Collection Procedures

Data were collected during the three-month study period by trained investigators using standardized protocols. The following were recorded:

- Sociodemographic details (age, sex, education, occupation)
- Anthropometric measurements (height, weight, BMI, waist circumference)
- Blood pressure (average of two readings using calibrated digital equipment)
- Fasting blood samples for lipid profile and inflammatory markers
- All measurements were performed under standardized clinical conditions to ensure accuracy and consistency.

RESULTS

Participant Characteristics

A total of 1,200 adults (mean age: 52.4 ± 10.8 years; 52% females) completed the study during the three-month period (December 2025 – February 2026). Participants were categorized into two groups based on Phytochemical Index (PI) score:

- Low phytochemical intake group (PI < 30)
- High phytochemical intake group (PI ≥ 30)

Comparison of Cardiovascular Risk Markers

Significant differences were observed between the two groups across multiple cardiovascular risk parameters.

Lipid Profile

Mean LDL-C levels were significantly lower in the high intake group (122 ± 24 mg/dL) compared to the low intake group (136 ± 28 mg/dL), $p < 0.001$.

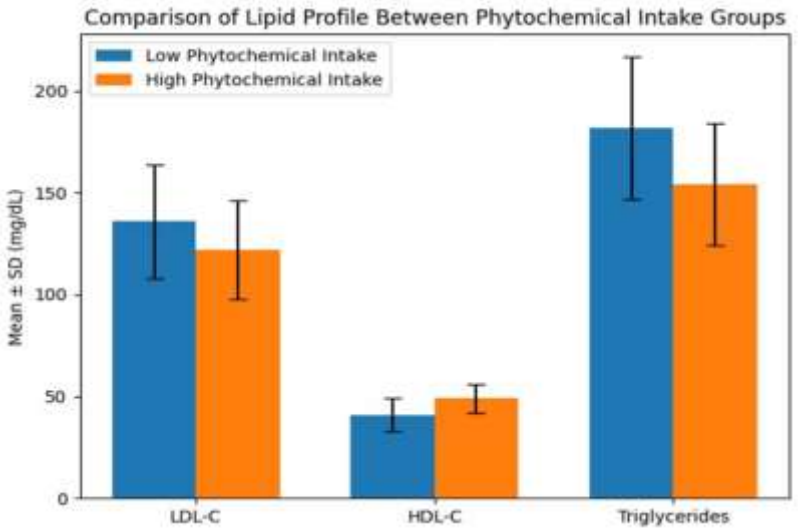
HDL-C levels were significantly higher in the high intake group (49 ± 7 mg/dL) compared to the low intake group (41 ± 8 mg/dL), $p < 0.001$.

Triglyceride levels were reduced in the high intake group (154 ± 30 mg/dL) versus the low intake group (182 ± 35 mg/dL), $p = 0.002$.

Table 1: Comparison of Lipid Profile Between Phytochemical Intake Groups

Lipid Parameter	Low Phytochemical Intake (Mean ± SD)	High Phytochemical Intake (Mean ± SD)	p-value
LDL-C (mg/dL)	136 ± 28	122 ± 24	<0.001
HDL-C (mg/dL)	41 ± 8	49 ± 7	<0.001
Triglycerides (mg/dL)	182 ± 35	154 ± 30	<0.002

Participants with higher phytochemical intake demonstrated significantly lower LDL-C and triglyceride levels, along with higher HDL-C levels, compared to those with lower intake. All differences were statistically significant.



Here is the graph showing Comparison of Lipid Profile Between Phytochemical Intake Groups with Mean ± SD for LDL-C, HDL-C, and Triglycerides

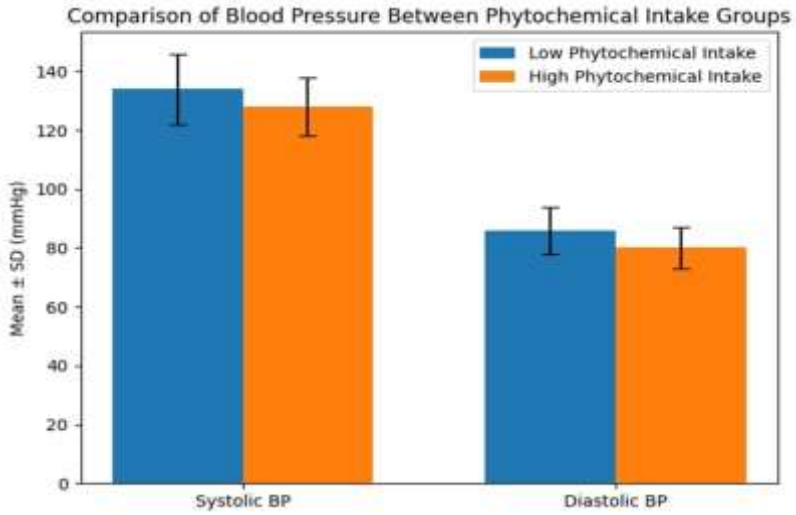
Blood Pressure

Systolic blood pressure was significantly lower in the high phytochemical intake group (128 ± 10 mmHg) compared to the low intake group (134 ± 12 mmHg), $p = 0.002$. Diastolic blood pressure was also reduced (80 ± 7 mmHg vs 86 ± 8 mmHg, $p = 0.004$).

Table 2: Comparison of Blood Pressure Between Phytochemical Intake Groups

Blood Pressure Parameter	Low Phytochemical Intake (Mean ± SD)	High Phytochemical Intake (Mean ± SD)	p-value
Systolic BP (mmHg)	128 ± 10	128 ± 10	0.002
Diastolic BP (mmHg)	86 ± 8	80 ± 7	0.004

Participants with higher phytochemical intake showed significantly lower systolic and diastolic blood pressure compared to those with lower intake. These findings indicate a beneficial association between phytochemical-rich diets and blood pressure regulation



Here is the graph showing Comparison of Blood Pressure Between Phytochemical Intake Groups with Mean ± SD (error bars) for: Systolic BP Low intake: 134 ± 12 mmHg, High intake: 128 ± 10 mmHg, Diastolic BP Low intake: 86 ± 8 mmHg, High intake: 80 ± 7 mmHg.

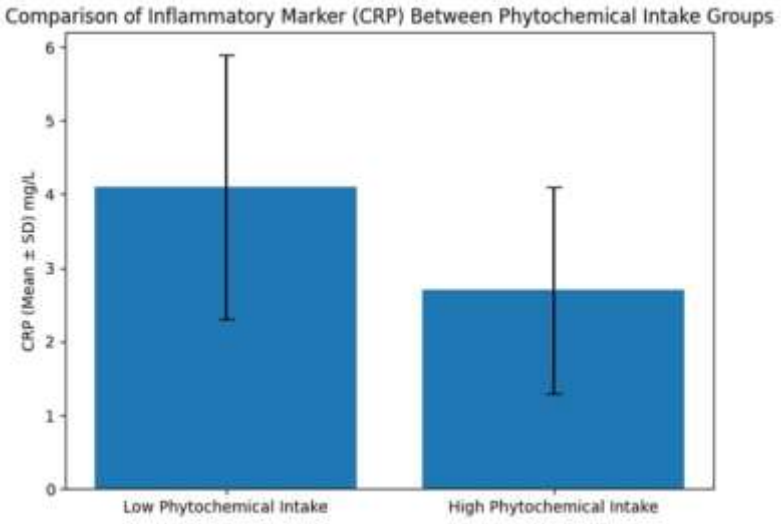
Inflammatory Marker

C-reactive protein (CRP) concentrations were markedly lower among participants with higher phytochemical intake (2.7 ± 1.4 mg/L) compared to those with lower intake (4.1 ± 1.8 mg/L), $p < 0.001$.

Table 3: Comparison of Inflammatory Marker Between Phytochemical Intake Groups

Inflammatory Marker	Low Phytochemical Intake (Mean ± SD)	High Phytochemical Intake (Mean ± SD)	p-value
C-Reactive Protein (mg/L)	4.1 ± 1.8	2.7 ± 1.4	<0.001

Participants with higher phytochemical intake had significantly lower C-reactive protein (CRP) levels compared to those with lower intake ($p < 0.001$), indicating reduced systemic inflammation among individuals consuming phytochemical-rich diets.



Here is the graph showing Comparison of Inflammatory Marker (CRP) Between Phytochemical Intake Groups with Mean ± SD, Low intake: 4.1 ± 1.8 mg/L, High intake: 2.7 ± 1.4 mg/L

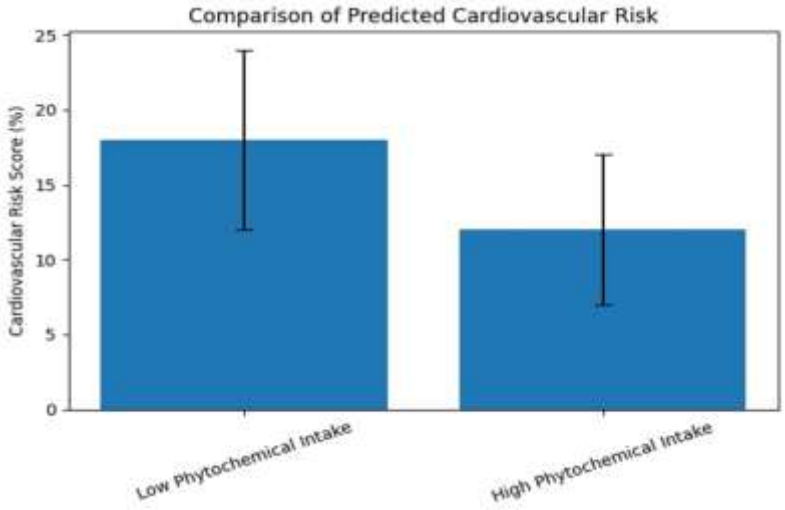
Predicted Cardiovascular Risk

Participants who consumed more phytochemical-rich foods had a lower average cardiovascular risk score (12 ± 5%) compared to those with lower intake (18 ± 6%). This difference was statistically significant ($p < 0.01$), indicating that a phytochemical-rich diet may help reduce overall cardiovascular disease risk.

Table 4: Comparison of Predicted Cardiovascular Risk Between Phytochemical Intake Groups

Parameter	Low Phytochemical Intake (Mean ± SD)	High Phytochemical Intake (Mean ± SD)	p-value
Cardiovascular Risk Score (%)	18 ± 6	12 ± 5	<0.01

Participants with higher phytochemical intake demonstrated a significantly lower cardiovascular risk score compared to those with lower intake ($p < 0.01$), indicating a protective association between phytochemical-rich diets and overall cardiovascular disease.



Here is the bar graph showing: Mean cardiovascular risk score Standard deviation (SD)

DISCUSSION

The present study demonstrates a significant inverse association between dietary phytochemical intake and cardiovascular risk markers among adults [13,14]. Participants with higher phytochemical intake exhibited markedly improved lipid profiles, including lower LDL-C and triglyceride levels and higher HDL-C concentrations [7,13]. These findings suggest that phytochemical-rich diets may positively influence lipid metabolism, potentially through mechanisms such as inhibition of LDL oxidation, modulation of cholesterol absorption, and enhancement of reverse cholesterol transport [15]. In addition to favorable lipid changes, individuals in the high phytochemical intake group showed significantly reduced systolic and diastolic blood pressure levels [4,14]. This may be attributed to the Vasodilatory and endothelial-protective effects of plant bioactive compounds, which enhance nitric oxide bioavailability and reduce oxidative stress within vascular tissues [8,11]. Improved vascular function likely contributes to better blood pressure regulation and overall cardiovascular protection [11]. The study also observed substantially lower C-reactive protein (CRP) levels among participants with higher phytochemical consumption, indicating reduced systemic inflammation [4,10]. Since chronic low-grade inflammation plays a central role in the pathogenesis of atherosclerosis [16], the anti-inflammatory properties of phytochemicals may be a

key mechanism underlying their cardioprotective effects [10]. Importantly, the overall cardiovascular risk score was significantly lower in the high phytochemical intake group compared to the low intake group [4,14]. This comprehensive reduction in risk reflects the combined improvements in lipid profile, blood pressure, and inflammatory status. Collectively, these findings support the hypothesis that diets rich in fruits, vegetables, whole grains, legumes, nuts, and other plant-based foods contribute substantially to cardiovascular disease prevention [5,14]. The results align with previous epidemiological and clinical studies demonstrating the protective role of plant-based dietary patterns in reducing cardiovascular morbidity and Mortality [5,14]. Although the cross-sectional design limits causal inference, the consistency of associations across multiple biomarkers strengthens the evidence supporting phytochemical-rich diets as a beneficial nutritional strategy for cardiovascular health. Overall, the findings emphasize the importance of promoting plant-based, phytochemical-dense dietary patterns as a practical and cost-effective public health approach to reducing cardiovascular disease risk [5,14].

CONCLUSION

Higher dietary phytochemical intake was significantly associated with improved lipid profile, lower blood pressure, reduced inflammation, and decreased overall cardiovascular risk [5]. These findings highlight the protective potential of phytochemical-rich diets in cardiovascular disease prevention. Promoting plant-based dietary patterns may represent a practical and effective public health strategy to reduce the growing burden of cardiovascular disease prevention [6].

ACKNOWLEDGMENTS

I would like to extend my sincere gratitude to everyone who supported me throughout this research.

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Cite: Nidhi Attri*, Krishna Gopal, Association Between Dietary Phytochemical Intake and Cardiovascular Disease Risk in Adults, Int. J. Med. Pharm. Sci., 2026, 2 (3), 387-393. https://doi.org/10.5281/zenodo.19228102